

PATENT SPECIFICATION

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(54) ARC WELDING APPARATUS

(71) We, FAGERSTA AKTIEBOLAG of Fack S-773 01 Fagersta, a Company incorporated under the laws of Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an arc welding apparatus.

Previously, in high-productive welding e.g. in production of stainless steel tubes, two or more non-consumable electrodes in the same body have been used where a so-called open arc, e.g. a TIG-arc, is maintained between each electrode and the workpiece. With a TIG-arc the heat transfer to the metal sheet is obtained through the upper side of the molten pool, which results in a shallow penetration profile. In welding with a multi-electrode torch of TIG-arcs a wide molten pool is therefore obtained and consequently a high consumption of energy per unity of length of the weld bead. Moreover, in a TIG-torch the electrode is rather unprotected, for which reason impurities from the surrounding air and from the molten pool can easily be conducted into the inert gas surrounding the electrode. This gives an increased wearing of the electrode. When this wearing has reached a certain stage, the electrode must be taken out from the torch to be re-grinded.

The aim of this invention is to produce a multi-electrode torch by means of which the said disadvantages will be eliminated and by means of which the welding speed and quality can be increased.

According to the invention there is provided an arc welding apparatus comprising a torch body, at least first and second non-consumable elongate electrodes, means for mounting said electrodes in said torch body adjustably in the direction of their length, at least first and second interchangeable nozzles, means to supply gas to issue from said nozzles, means for removably and interchangeably mounting said nozzles in said torch body,

said nozzles being adapted to be employed in conjunction with any of said electrodes, and wherein said first nozzle in conjunction with any suitably longitudinally adjusted one of said electrodes is capable of providing an inert gas torch which forms, in use, an open arc between said electrode and a workpiece, and said second nozzle in conjunction with a suitably longitudinally adjusted other of said electrodes is capable of providing a plasma-arc torch which forms, in use, a constricted arc between said electrode and said workpiece.

The invention will be described more in detail in connection with the attached drawing, which diagrammatically shows the construction of a multi-electrode torch.

In the figure a form of realization is shown comprising three torches, arranged in a row, enclosed by a torch block. In the electrode holder 1 the electrodes 4, 5 and 6 are arranged to be vertically displaceable. These are of nonconsumable type. The electrodes are also arranged to be laterally displaceable as a whole, maintaining their respective lateral separation. Between the torch body 3 and the electrode holder 1 is arranged an insulator 2 of ceramic material. Around every electrode of the torch body a duct 10 is bored into which inert plasma-forming gas is let in. In the torch body nozzles 7, 8 and 9 are mounted. The function of the nozzle 7, encircling the electrode 4, is only to protect the torch body and, consequently, it does not influence the arc. The nozzle 8, co-operating with the electrode 5 is a plasma-arc nozzle which forms a constricted arc and the nozzle 9, co-operating with the electrode 6, is designed to form a less constricted arc. In the drawing, the tip of the electrode 6 is adjusted to be within the duct of the nozzle.

Under the torch block the workpiece 14 is placed, which workpiece is arranged to move in the direction of the arrow 15. The electrodes 4, 5 and 6 are fed from separate power sources 11, 12 and 13 respectively, which are also connected to the workpiece 14. The nozzles of the torch body are

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interchangeable so that for instance the nozzle 7 can be exchanged for a plasma-arc nozzle 8 or 9. The electrodes 4, 5 and 6 are displaceable in order to be at a suitable distance of the co-operating nozzle. The inert plasma-forming gas of the respective torches is individually controlled. In the same way there is individual control of the current to every electrode.

10. By exchange of nozzle and suitable adjusting of the electrode is obtained from each electrode either TIG-arc or plasma arc, more or less constricted. The TIG-arc from electrode 4 is a so-called open arc, i.e. the wall of the nozzle has no influence on the arc. The plasma-arc from electrode 5 consists of a so-called constricted arc, i.e. the wall of the nozzle keeps the arc constricted to a thin pencil. A weak influence on the arc from the wall of the nozzle is generated from the less constricted plasma arc from the electrode 6, whereby a less constricted arc is obtained. In welding sheet metal with a constricted arc the so-called key-hole effect is often used. Thereby a great part of the energy transfer from the arc takes place within the metal, i.e. a penetration profile with a high depth-width ratio is obtained.

30 With the described multi-electrode torch any one of the said types of arcs can be chosen for every electrode. In the shown design with three electrodes 27 different variants of arc combinations can thus be obtained. With the described torch unit it is possible to control the energy transfer to the metal in an optimal way, in order to avoid getting the wide molten zone, which is obtained with a multi-electrode torch consisting of merely TIG-torches. This reduces the risk of weld defects such as hot tears and allows an increase of the welding speed. Moreover, the electrodes in the described unit are well protected from the surrounding air and molten metal. Thereby a long service length of the electrodes can be achieved with less number of production interruptions for grinding the electrodes.

50 The arc welding apparatus is not limited to the described design but a number of variants of torch combinations are, as has been mentioned, possible within the scope of the invention as defined by the appended claims.

55 WHAT WE CLAIM IS:—

1. Arc welding apparatus comprising a torch body, at least first and second non-consumable elongate electrodes, means for mounting said electrodes in said torch body adjustably in the direction of their length, at least first and second interchangeable nozzles, means to supply gas to issue from

said nozzles, means for removably and interchangeably mounting said nozzles in said torch body, said nozzles being adapted to be employed in conjunction with any of said electrodes, and wherein said first nozzle in conjunction with any suitably longitudinally adjusted one of said electrodes is capable of providing an inert gas torch which forms, in use, an open arc between said electrode and a workpiece, and said second nozzle in conjunction with a suitably longitudinally adjusted other of said electrodes is capable of providing a plasma-arc which forms, in use, a constricted arc between said electrode and said workpiece.

2. Apparatus according to Claim 1, wherein said electrodes and their associated nozzles are arranged to be laterally displaceable as a whole.

3. Apparatus according to Claim 1 or 2 comprising a third non-consumable electrode including means to mount said third electrode in said torch body adjustably in the direction of its length, and a third interchangeable nozzle including means to removably and interchangeably mount said third nozzle in said torch body, said nozzle being adapted to be employed in conjunction with any suitably longitudinally adjusted one of the first, second or third electrodes and being capable of providing a plasma-arc between said electrode and said workpiece which is more constricted than the arc obtained employing said second nozzle.

4. Arc welding apparatus substantially as hereinbefore described with reference to the accompanying drawings.

5. Method of arc welding using are welding apparatus comprising a torch body, at least first and second non-consumable elongate electrodes, means for mounting said electrodes in said torch body adjustably in the direction of their length and for vertical positioning therein with respect to a workpiece, at least first and second interchangeable nozzles, means to supply gas to issue from said nozzles, means for removably and interchangeably mounting said nozzles in said torch body, said nozzles being adapted to be employed in conjunction with any of said electrodes; said method comprising vertically positioning said electrodes with respect to the workpiece, forming an open arc between an electrode and a workpiece by means of an inert gas torch constituted by said first nozzle in conjunction with any of said electrodes, and forming a constricted arc between an electrode and said workpiece by means of a plasma-arc torch constituted by said second nozzle in

conjunction with another of said electrodes.

- 5 6. A method of arc welding as claimed in Claim 5 and substantially as hereinbefore described with reference to the accompanying illustrative drawings.

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